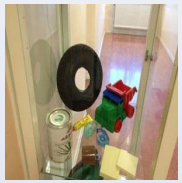
LARGE CRUDE TALL OIL SPILL IN SENSTIVE ARCHIPELAGO

What is Crude Tall Oil?

Crude Tall Oil (CTO) is a by-product from the black liquor when manufacturing pulp and paper (the sulphate process). CTO contains fatty acids, resin acids and neutral substances and traces of lignin. It is a dark brown, viscous and sulfur-containing liquid that may be used as a heavy mineral oil substitute in boilers. It also contains valuable chemical substances, which may be refined into fuel additives or green chemicals; most of the CTO is used for these purposes. By distilling the oil, tall oil fatty acid, pine resin and pitch oil are extracted and used.

CTO is classified as hypoallergenic and may cause headache by inhalation due to certain volatile components. Chemically, the CTO contains a fraction of resin oil which may be toxic to aquatic organisms such as fish larvae and plankton.



Examples of products which include the distillate from CTO (from Arizona Chemicals Exhibition at the factory in Sandarne)

CTO from the spill in Söderhamn is being cleaned-up from inside a jetty

There are very few incidents reported on CTO spills. The general notion is that it is harmless to the environment since it origins from coniferous trees. The name originated as an Anglicization of Swedish "tallolja" ("pine oil"). Although CTO is less harmful compared to mineral oil, release of CTO, especially large quantities, may also cause severe environmental damage to aquatic systems and to impacted shores. CTO may also cause allergic reactions to humans and mammals.

The physical properties of CTO are similar to petroleum-based oil and may impact birds in the same way, e.g. by smearing the plumage and causing intoxication orally when cleaning feathers or skin.

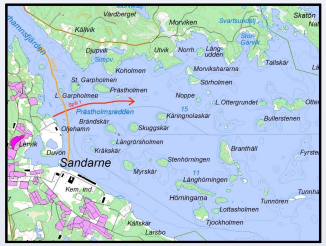
The long-term environmental effect of CTO depends on several matters; the toxicity of the oil mixture, the concentration in the environment, when the spill occurred (season, weather conditions), and on how quickly the CTO is degraded by natural processes. The decomposition is oxygen- consuming, which could may a local negative impact on the seabed and in smaller bodies of water.

What happened? Actions taken after the fact.

The two incidents

In 2011, right before Christmas, the Swedish coastline suffered a major oil spill of about 800 tonnes of CTO from a land based tank farm on the east coast, into the Söderhamn archipelago in the brackish Baltic Sea. In 2012, a second spill of 0.4 m³ occurred from the factory premises. The first spill had major impacts on the archipelago, at least 25 km of the coastline, and several islands were contaminated by the CTO to different degrees. The second spill impacted about 2 km coastline, areas not impacted by the first spill. The arrows in the figure below indicate the main direction of the oil's movement during each incident. The impacted area exhibit a high ecological value and is frequently used for outdoor recreation and a large number of private properties.

MAP OVER THE INNER PART OF SÖDERHAMN ARCHIPELAGO



The red arrow indicates the direction of the oil movement after the first spill in 2011. The orange arrow indicates the direction of the oil movement after the second spill in 2012.

Response

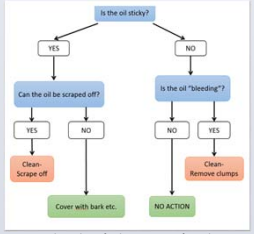
Immediately after the first spill, the archipelago was divided into area zones with names and numbers for proper documentation for future clean-up and monitoring. It should be noted that each zone was selected from a practical remediation perspective and not based on the impact and amount of oil in a particular area. Relevant NGO's were contracted in the beginning.

Early communication with the public was a crucial factor - Meetings with the public were held regularly, the first just less than two weeks after the first incident to share information about the remediation process and to answer questions.

The issue regarding "how clean is clean" was discussed already at the first public meeting and successively in order to create a consensus among all stakeholders what should be considered "clean" and what is sufficient remediation. This approach was important to avoid any unrealistic expectations that the oil would disappear completely and that shortly after the clean-up there would be no signs of an oil spill.

Remediation

The shores of the Söderhamn Bay consist mainly of rocky beaches, large rocks as well as very small pebble stones. Since the oil also got into jetties, the entire clean-up process has been difficult and time consuming, also due to the cold weather conditions in the north.



Decision-making scheme for the assessment of remediation need. (Adopted from Assessment criteria for how "clean" is "clean" in a sustainable society? Oil- and chemical spills, IVL 2007)

The remediation of beaches has been carried out in several phases; the first phase involved removal of loose oil in open waters, the second phase involved a rough cleanup or spreading, of bark followed by a more thorough cleanup phases.

Thanks to the Swedish Coast Guard, that initially made heavy duty removal of oil in open waters and close to shores, the impacted beaches were reduced.

The remediation that was carried out on beaches was solely done manually. Initially the beaches were cleaned up coarsely, i.e. wherever possible, the oil was scraped off using tools such as shovels and spatulas. By preventing the oil to spread any further, secondary contamination were avoided. In some areas, spreading of bark was the only action taken, due to limited accessibility, weather conditions or simply lack of time etc. The main purpose for using bark is to prevent damage to birds due to the stickiness of the oil.

After the initial cleanup, most areas were remediated in more detail, in some cases several times.

One of the Coast Guard's beach cleanup equipment boats

A late degradation stage of CTO. The white film may be brushed off

CTO may after some time in the water form into a tennis ball-like shape, white on the outside with yellow almost fresh oil inside

An example of an area that may have been cleaned too harshly. Large areas of vegetation and root cover have been removed which has probably contributed to the slow recovery.

An example of a meadow that has recovered well. No vegetation was removed.

Results and impact

The clean-up process in Söderhamn has been very successful and was ended in the spring of 2016.

The impact to the bird population was minimal since most birds had migrated for the winter. The incident happened during late fall/early winter, when the biological activity in marine organisms is low; hence low impact on the marine organism's active reproductive periods. In Söderhamn, fatty acids, resin acids and sterols have been sampled in sediments, fish muscle, and mussels. Limited impact could be noted, although well established test methods are missing for CTO.

The CTO degradation period on the shores was much longer than expected. In a laboratory, the degradation period during optimal conditions is short; about 80 % of the oil is degraded after about one month. The field studies proved however, that the degradation period could be years, especially if the oil was trapped in a jetty, with no impact from sun, wind, waves and ice. The thickness of the oil layer was also a factor, a thicker layer would be more persistent to degradation.

The impact on the beaches is difficult to monitor since the situation prior to the spill is unknown. It could be noted, however, that some species benefited from the oil, like e.g. Alder.

Key lessons from the CTO remediation process

The question "how clean is clean" should be discussed at an early stage in the remediation process, preferably before remediation commencement, in order to create a consensus among all stakeholders regarding "how clean is clean" and in what time period to avoid unreasonable expectations. The Swedish Agency for Marine and Water Management (Sweco as experts) recommends avoiding terms such as "restore to its original condition" to define the desired results after remediation efforts. It is impossible to completely restore an oil-damaged beach to the original condition through cleanup efforts, even if made with care. It is very important to establish standards regarding e.g. acceptance of color stains and minor oil residues in some areas. Such a dialogue with the public, political representatives, government agencies, and other stakeholders is crucial to avoid bad solutions for the environment.

In general, clean-up should be made with care, facilitating natural degradation as much as possible. Based on past experience from mineral oil spills, harsh remedial actions may result in a slower recovery rate compared to areas which have been cleaned up in a more carful manner and allowed to recover at their own pace. Nature's own ability to degrade oil spills on a beach has often been underestimated, even though this could be an efficient decomposition process.

Why not go all in with respect to cleanup?

- Such a process may results to more harm than good and , such as reduced lichen cover, removal of important microorganisms, increased soil erosion and difficulties for vegetation to recover.
- Aggressive remediation efforts may sterilize the environment and give rise to long-term environmental damage.
- In some cases, small amounts of oil-contaminated gravel, rocks, and natural sand on natural beaches left behind will not cause more harm than good, especially because it is impossible to replace such natural sand on these beaches.
- Observations from case studies show that extensive remediation do not increase the recovery rate of oil-impacted beaches.
- Harsh cleaning methods, such as high pressure washing with cold water or blasting with wood pellets or sand could be applicable on e.g. artificial structures such as bridges or ports, but should obviously be avoided on natural beaches.

An important part of the process is to allow time for natural recovery.

A crucial part of the process is to make systematic inventories to follow-up the progress to assess whether there is a need for further cleanup or if the natural degradation is sufficient.

Some rules of thumb

- If the oil is sticky, due the risk of secondary contamination; remove as much as possible, this is applicable to most types of shores. If lack of time or the area is difficult to access, apply bark, peat or some material that may naturally degrade if left on the premises.
- All cleanup staff must be supervised during the cleanup process and should have some basic training and instructions prior to start-up of the works.
- Staff with environmental training should be supervising the cleanup process to avoid risk of applying the wrong methods or overdoing it.
- Go back (a team of experienced staff in different capacities) regularly for assessment of the need for further actions.
- Continuous communication with the public, media, political representatives, NGO's, etc. Bring in relevant NGO's early in the process.

More info/References

www.arizonachemical.com

Decontamination Manual for oil on Swedish beaches – MSB – 2010

Assessment Criteria for how "clean" is "clean"? – IVL - 2007

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